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प्रयोगात्मक भारतीय मानक
Tentative Indian Standard

परिवर्तीय अवस्थाओं में प्लास्टिक की जैवनिम्निकरणता का आंकलन

Assessment of Biodegradability of Plastics in Varied Conditions

ICS 83.80.01

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भारतीय मानक ब्यूरो
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Plastics Sectional Committee, PCD 12

FOREWORD

This provisional Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

Through Plastic Waste Management (PWM) Rules 2021, the Government of India prohibited manufacturing, import, stocking, distribution, sale and use of several single use plastics (SUPs) from 1st July 2022. The Rule 10 of PWM Rules 2016 “Protocols for Compostable Plastic Material” has been substituted with “Protocols for Compostable and Biodegradable Plastic Materials” through Draft PWM Rules 2022. The rule states that Biodegradable Plastics shall be as per appropriate Standard developed by Bureau of Indian Standards.

Therefore, due to urgent need of Indian Standard for implementation of PWM Rules, the Committee has decided to formulate a comprehensive indigenous Indian Standard for biodegradable plastic. As the technology is new and there are no international standards and validated data for the biodegradation of Plastics in environment like aqueous and marine medium, the Committee has decided to formulate a provisional Indian Standard as per Rule 27 of BIS Rules, 2018. This provisional Standard has been formulated to specify the procedures for assessment of the biodegradability of plastic in available varied conditions.

This provisional standard specifies the procedures for assessment of biodegradability of plastics, negative effects of resulting biomass on terrestrial plant growth/organism and regulated heavy metals present in the biomass. This standard is applicable only for the assessment of biodegradability of plastics in composting medium, soil medium, municipal solid waste medium and aqueous medium. In this standard, the criteria for assessing the biodegradability of plastics are applicable only in soil medium, municipal solid waste medium and composting medium.

At present, there are no test methods available internationally to determine the biodegradability of plastic in marine environment. The test methods are being developed by ISO for the same. Due to the unavailability of test methods and validated data, biodegradation in marine environment is not covered in this standard.

This provisional standard contains the limits of regulated heavy metals to ensure safe application of biomass. The values of the regulated heavy metals given in Table 1 and Table 2 have been taken from the Schedule II of Solid Waste Management Rules, 2016.

This standard does not specify the service life or durability aspects of the plastic material under consideration.

As per the definition of biodegradable plastic given in Plastic Waste Management Rules 2016, duly amended, the plastic material should not leave behind any micro plastics, or visible, distinguishable, or toxic residue, which has adverse environment impacts. There are no validated test methods available for testing of microplastic, the same will be introduced in the standard once available. Till the validated test methods are available, the 90 percent biodegradation shall be considered as a safe threshold to rule out the presence of microplastic.

As per rule 27 of BIS rules, the provisional Indian Standard shall not be used for Standard Mark.

As per the recommendation of the Plastics Sectional Committee, and with the approval of Petroleum, Coal and Related Products Division Council, this provisional standard is valid for a period of 2 years from the date of its establishment. Before the expiry of the validity period, this provisional standard will be once again reviewed by the Sectional Committee and will be established as a regular Indian Standard. However, if the Sectional Committee is of the opinion that such standard should not be established, with or without modification, as a regular Indian Standard, then this provisional Indian Standard shall lapse after its validity period.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Tentative Indian Standard

ASSESSMENT OF BIODEGRADABILITY OF PLASTICS IN VARIED CONDITIONS

1 SCOPE

1.1 This provisional standard specifies the procedures and assessment of biodegradability of plastics under varied conditions. This provisional standard addresses the following aspects:

a) Biodegradation
b) Negative effects of resulting biomass on terrestrial plant growth/organism.
c) Negative effects of the quality of the resulting biomass including the presence of high levels of regulated heavy metals.

1.2 The provisional standard is applicable for assessing the biodegradability of plastics under aerobic, anaerobic conditions.

1.3 The provisional standard is not applicable for assessing the biodegradability of plastics under marine environment.

1.4 The assessment of biodegradability of plastic, if done through composting conditions only, vide IS/ISO 14855-1 and IS/ISO 14855-2, the plastic shall be certified as compostable plastic, and not as biodegradable plastic as defined under PWM Rules 2016, as amended.

1.5 This provisional standard excludes compostable plastics as per IS/ISO 17088, as per PWM Rules 2016, as amended.

2 REFERENCES

The standards and the other publications listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

IS No./Other publication	*Title*
IS 2828 : 2019/ ISO 472 : 2013	Plastics — Vocabulary (*second revision*)
IS 3025 (Part 65) : 2022 /ISO 17294-2 : 2016	Methods of sampling and test (Physical and Chemical) for water and wastewater: Part 65 Application of inductively coupled plasma mass spectrometry (ICP-MS) — Determination of 62 elements (*first revision*)
IS/ISO 14851 : 1999	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by measuring the oxygen demand in a closed respirometer
IS/ISO 14852 : 1999	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide
IS/ISO 14853 : 2016	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system — Method by measurement of biogas production (*first revision*)
IS/ISO 14855–1 : 2012	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide : Part 1 General method (*first revision*)

IS No./Other publication	*Title*
IS/ISO 14855-2 : 2018	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide: Part 2 Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test (*first revision*)
IS 15109 (Part 2) : 2002 /ISO 11269-2 : 1995	Soil quality — Determination of the effects of pollutants on soil flora: Part 2 Effects of contaminated soil on the emergence and early growth of higher plants (*first revision*)
IS/ISO 15985 : 2014	Plastics — Determination of the ultimate anaerobic biodegradation under high-solids anaerobic-digestion conditions — Method by analysis of released biogas (*first revision*)
IS/ISO 17088 : 2021	Compostable plastics — Specification (*second revision*)
IS/ISO 17556 : 2019	Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved (*second revision*)
ISO 11268-1	Soil quality — Effects of pollutants on earthworms — Part 1: Determination of acute toxicity to Eisenia fetida/Eisenia Andrei
ISO 11268-2	Soil quality — Effects of pollutants on earthworms — Part 2: Determination of effects on reproduction of Eisenia fetida/Eisenia Andrei
OECD 208 : 2016	Terrestrial plant test: Seedling emergence and seedling growth test

3 TERMINOLOGY

3.1 For the purpose of this provisional standard, definition given below and in IS 2828 shall apply.

3.2 Compostable Plastics[1]

Plastic that undergoes degradation by biological process during composting to yield carbon dioxide, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leave no visible, distinguishable or toxic residue.

3.3 Microplastic

Any solid plastic particle insoluble in water with any dimension between 1 µm and 1 000 µm (=1 mm).

NOTE — The above definition is being formalised at ISO technical committee, once finalized, the definition would be adopted from the ISO document.

3.4 Ultimate Aerobic Biodegradation[1]

Breakdown of an organic compound by microorganisms in the presence of oxygen into carbon dioxide, water and mineral salts of any other elements present (mineralization) plus new biomass.

3.5 Ultimate Anaerobic Biodegradation[2]

Breakdown of an organic compound by microorganisms in the absence of oxygen to carbon dioxide, methane, water, and mineral salts of any other elements present (mineralization) plus new biomass.

NOTES:
1 As per IS/ISO 17088
2 As per IS/ISO 15985

4 REQUIREMENTS

4.1 The purpose of this provisional standard is to establish the requirements for plastics to meet the desired criteria under varied conditions. In order to comply with this document, plastics shall demonstrate biodegradation (aerobic or anaerobic), safe limits for toxic residue and no adverse effects on environment as mentioned in **4.2** to **4.4**.

4.2 The level of biodegradability of the plastics shall be assessed by testing under controlled conditions as given below.

4.2.1 *Ultimate Aerobic Biodegradability*

The ultimate level of aerobic biodegradation shall be established by testing under controlled conditions in accordance with the following standards:

IS Number	*Conditions*
IS/ISO 14851	Aqueous medium (activated sludge from a sewage treatment plant)
IS/ISO 14852	Aqueous medium (activated sludge from a sewage treatment plant)
IS/ISO 14855 (Part 1)	Composting
IS/ISO 14855 (Part 2)	Composting
IS/ISO 17556	Soil

4.2.2 *Ultimate Anaerobic Biodegradability*

The ultimate level of anaerobic biodegradation shall be established by testing under controlled typical anaerobic digestion conditions in accordance with the following standards:

IS Number	*Conditions*
IS/ISO 15985	Municipal solid waste
IS/ISO 14853	Aqueous medium (sludge with reduced inorganic carbon content less than 20 mg/l)

NOTES:

1 The plastic meeting the biodegradability criteria as per IS/ISO 14855-1 and IS/ISO 14855-2, shall only be considered for certification as ‘Compostable plastics’ in accordance with PWM Rules 2016, as amended.

2 Further, this provisional standard excludes ‘Compostable plastics’ as per IS/ISO 17088, under PWM Rules 2016, as amended.

4.3 Assessment of Toxic Residues

4.3.1 The assessment of toxic residues (regulated metal content) can only be analyzed after successful completion of the biodegradation phase.

4.3.2 The resultant biomass shall be analyzed for heavy metal content as per Table 1 and Table 2 and tested as per IS 3025 (Part 65).

4.4 Assessment of Adverse Effect on Environment

4.4.1 The plastics shall have no adverse effect on the environment, which includes terrestrial organisms. Thus, the analysis requires determination of eco toxicity testing as per column 4 of Table 1 and Table 2, for assessment of adverse effect of resulting biomass on terrestrial environment and plant growth test.

4.4.2 The biodegradability of the plastics under various conditions should confirm to the following requirements as specified in Table 1 or Table 2.

Table 1 Assessment of Aerobic Biodegradability in Plastics under varied conditions
(*Clauses* 4.3 *and* 4.4)

Sl No. (1)	**Characteristics** (2)	**Requirement** (3)	**Method of Test, Ref to** (4)
i)	Ultimate aerobic biodegradability of plastic materials under composting conditions, *Min*	90 percent by the end of the test period of 180 days	IS/ISO 14855-1 or IS/ISO 14855-2
	Ultimate aerobic biodegradability of plastic materials in an aqueous medium, *Min*	- do -	IS/ISO 14851 or IS/ISO 14852
ii)	Ultimate aerobic biodegradation of plastic materials in soil, *Min*	90 percent of the max level of biodegradation has been reached typically not exceeding six months but no longer than 2 years	IS/ISO 17556
	Regulated Heavy Metal Analysis		
iii)	Arsenic (as As), mg/kg on dry mass basis, *Max*	10.00	IS 3025 (Part 65)
iv)	Cadmium (as Cd), mg/kg on dry mass basis, *Max*	5.00	
v)	Chromium (as Cr), mg/kg on dry mass basis, *Max*	50.00	
vi)	Copper (as Cu), mg/kg on dry mass basis, *Max*	300.00	
vii)	Lead (as Pb), mg/kg on dry mass basis, *Max*	100.00	
viii)	Mercury (as Hg), mg/kg on dry mass basis, *Max*	0.15	
ix)	Nickel (as Ni), mg/kg on dry mass basis, *Max*	50.00	
x)	Zinc (as Zn), mg/kg on dry mass basis, *Max*	1000.00	
	Eco-toxicity Test		
xi)	Assessment of adverse impact on environment (Terrestrial plants growth test), *Min*	90 percent plant germination and plant biomass compared to control.	OECD 208 / ISO 11269-2 / Annex-C of IS/ISO 17088
xii)	Determination of acute/chronic ecotoxicity effects to earthworm, *Min*	90 percent of surviving earthworm grown in sample compost exposed to test material as well as reference compost exposed to reference material	ISO 11268-1 / Annex-D of IS/ISO 17088 and ISO11268-2 / Annex-E of IS/ISO 17088

Table 2 Assessment of Aerobic Biodegradability in Plastics
(*Clauses* 4.3 *and* 4.4)

Sl No. (1)	**Characteristics** (2)	**Requirement** (3)	**Method of Test, Ref to** (4)
i)	Ultimate anaerobic biodegradation, *Min*	90 percent within 2 years	IS/ISO 15985 or IS/ISO 14853
	Regulated Heavy Metal Analysis		
ii)	Arsenic (as As), mg/kg on dry mass basis, *Max*	10.00	As per IS 3025 (Part 65)
iii)	Cadmium (as Cd), mg/kg on dry mass basis, *Max*	5.00	
iv)	Chromium (as Cr), mg/kg on dry mass basis, *Max*	50.00	
v)	Copper (as Cu), mg/kg on dry mass basis, *Max*	300.00	
vi)	Lead (as Pb), mg/kg on dry mass basis, *Max*	100.00	
vii)	Mercury (as Hg), mg/kg on dry mass basis, *Max*	0.15	
viii)	Nickel (as Ni), mg/kg on dry mass basis, *Max*	50.00	
ix)	Zinc (as Zn), mg/kg on dry mass basis, *Max*	1000.00	
	Eco-toxicity Test		
x)	Assessment of adverse impact on environment (Terrestrial plants growth test), *Min*	90 percent plant germination and plant biomass compared to control.	OECD 208 / ISO 11269-2 / Annex-C of IS/ISO 17088
xi)	Determination of acute/chronic ecotoxicity effects to earthworm, *Min*	90 percent of surviving earthworm grown in sample compost exposed to test material as well as reference compost exposed to reference material	ISO 11268-1 / Annex-D of IS/ISO 17088 and ISO11268-2 / Annex-E of IS/ISO 17088

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Plastics Sectional Committee, PCD 12

Organization	*Representative(s)*
Central Institute of Plastics Engineering & Technology (CIPET), Chennai	Prof (Dr) Shishir Sinha (***Chairman***) Dr S. N . Yadav Dr Smita Mohanty (*Alternate*)
CSIR-Central Food Technological Research Institute (CFTRI), Mysore	Shri R. S. Matche
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Sabic Innovative Plastics, Bengaluru	Dr Sumanda Bandyopadhyay Shri Sunil Rauto (*Alternate*)
Haldia Petrochemicals Limited, Kolkata	Shri Raj K. Datta Shri Suvomoy Ganguly (*Alternate*)
Ministry of Environment & Forests (MoEF), New Delhi	Shri Satyendra Kumar Shri Amit Love (*Alternate*)
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All India Plastics Manufacturers Association (AIPMA), New Delhi	Shri Deepak Ballani

Organization	*Representative(s)*
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Plastindia Foundation, Mumbai	DR E. SUNDARESAN SHRI HITEN BHEDA (*Alternate*)
Central Pollution Control Board, New Delhi	MS DIVYA SINHA SHRI C. K. DIXIT (*Alternate*)
National Committee on Plasticulture Applications in Horticulture (NCPAH), Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi	SHRI ANAND ZAMBRE SHRI KRISHNA KUMAR KAUSHAL (*Alternate*)
Indian Oil Corporation, R&D Centre, Faridabad	SHRI DHANANJAY SAHOO
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Consumer Association of India (CONCERT), Chennai	SHRI G. SANTHANARAJAN SHRI M. R. KRISHNAN (*Alternate*)
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Member Secretary
Shri Shivam Dwivedi
Scientist ‘B’ (PCD), BIS

Panel for Preparing Standard on “Assessment of Biodegradability of Plastics in Varied Conditions”

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Biotecbags, Bangalore	Dr T. S. Shankker
CSIR-IITR, Lucknow	Dr V. P. Sharma
HMEL, Noida	Shri Vineet Gupta
MoEF&CC, New Delhi	Dr Amit Love (*Special invitee*)
CPCB, New Delhi	Ms Divya Sinha (*Special invitee*)
ITC, Bangalore	Dr Kamal Tyagi (*Special invitee*)

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Review of Indian Standards

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Amendments Issued Since Publication

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